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STEP-AIRSEDS
System Engineering Support

FINAL REPORT

Reference: Contract No. H-31420D

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Submitted to:
Mr. Randy Baggett/TD15
George C. Marshall Space Flight Center
Marshall Space Flight Center, AL 35812

Alpha Technology, Inc.
3322 South Memorial Parkway, Suite 630, Huntsville, AL 35801
(256) 883-1373

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PURCHASE ORDER NO. H-31420D
SPACE TRANSPORTATION
Using
ELECTRODYNAMIC PROPULSION
ATMOSPHERIC IONOSPHERIC RESEARCH
SMALL EXPENDABLE DEPLOYER SATELLITE
FINAL PEPORT

This report summarizes and highlights the activities in support of the Space Transportation using Electrodynamic Propulsion Atmospheric Ionospheric Research Small Expendable Deployer Satellite (STEP-AIRSEDS) Project for the period of May 16, 2000 through September 28, 2001.

The Alpha Technology, Inc. was tasked to provide support to the MSFC in requirements development and in verification activities. Specifically, the Alpha Technology, Inc. task was to: (1) develop and maintain the STEP-AIRSEDS Project System Requirements Database; (2) develop and maintain the STEP-AIRSEDS requirements verification definition and planning support database; (3) perform requirements flow down analysis of STEP-AIRSEDS Project System Requirements to TMTC Level IV Requirements; (4) provide system engineering guidance to the Project as needed; (5) provide guidance to TMTC in preparation of Level IV Requirements; and (6) provide support to STEP-AIRSEDS meetings, reviews, and telecons as needed.

A preliminary STEP-AIRSEDS Project System Requirements RVC Database was developed and submitted to the Project in September of 2000. The database was updated based on the latest STEP-AIRSEDS study results and coordination with TMTC and was submitted to the Project Office on December 15, 2000 for MSFC and TMTC review. A partial tabletop review of the STEP-AIRSEDS Project System Requirements RVC Database was conducted with MSFC and TMTC on February 27, 2001. Subsequent to the table top review the decision was made by the Project Office to develop a STEP-AIRSEDS Project Requirements Document (PRD) defining the top level requirements for the project in lieu of the STEP-AIRSEDS Project System Requirements RVC Database. A draft STEP-AIRSEDS PRD was developed and submitted to the Project Office for review on March 13, 2001. Approved review comments were incorporated into the PRD and the updated version of the PRD was submitted to the Project Office on April 5, 2001 for posting on the MSFC Virtual Research Center (VRC). A final update of the Project PRD was made in September of 2001 and was submitted to the Project Office.

Several TMTC developed STEP-AIRSEDS documents were reviewed during the course of the task. Documents reviewed included the Master Test Plan, the Optimal Tether Report, the STEP-AIRSEDS Deployer System Development Report, and several other test plans, study reports, and test procedures. Review comments and recommendations were submitted to the Project office for consideration. Telecons with TMTC covering the document review comments were supported.

Recommendations and guidance was provided to TMTC throughout the period of the task in development of the Level IV system requirements. Both general comments and recommendations and detailed examples in the form of a Project STEP-AIRSEDS System Requirements Database were provided to TMTC as a guide in the requirements development. An assessment of the draft TMTC System Requirements Database was performed in May of 2001 and recommended changes, with examples, were submitted to the Project Office and TMTC for consideration.

A second version of the TMTC requirements was received on September 1, 2001. These requirements were in the form of a Project Requirements Document and defined only the additional requirements that were expanded from the MSFC STEP-AIRSEDS Project Requirements Document (PRD) as a continuation of the MSFC PRD requirements as sub-paragraphs. As such, the document is not a stand-alone set of requirements. The next level of requirements should be the system requirements defined in full to stand alone with all PRD requirements flowed down. The September version of the system requirements was of less maturity than the earlier draft version. A considerable effort is required to adequately define the Level IV system requirements.

Support was provided for the STEP-AIRSEDS Program Review conducted by TMTC at MSFC on June 13 and 14, 2001. Support was also provided as required for meetings and bi-weekly telecons and to TMTC in their development of the system requirements database.

A requirements flowdown analysis was conducted and a requirements flowdown matrix was developed to link the TMTC system requirements to the STEP-AIRSEDS PRD requirements. The analysis was based on the latest TMTC requirements provided at that time. The flowdown analysis resulted in identifying a significant number of PRD requirements with no flowed down or linked system requirement. The TMTC System Requirements Database, as provided to Alpha Technology, is considered incomplete. All PRD requirements should be flowed down to the next level (TMTC System Requirements Database) of requirement. Also, many of the requirements in the TMTC System Requirements Database are not complete in the RVC definition format and many should be reworded in a requirement statement structure.

A second requirements flowdown analysis was performed with a requirements flowdown matrix, based on the final TMTC PRD requirements, provided. This flowdown analysis also resulted in a significant number of MSFC PRD requirements with no flowed down or linked system requirement and is reflected in the requirements flowdown matrix provided.

The following recommendations are submitted for consideration:
1. The STEP-AIRSEDS Contractor to continue to develop the STEP-AIRSEDS System Requirements in the filemaker database format. The system level requirements must be specific as to the requirement statement, a valid requirement, and be verifiable, accurate and complete. These requirements should be completed in the late formulation phase of

the project for the SRR. It is recommended that table top reviews of the requirements be performed by the MSFC and Contractor project teams. Both the MSFC PRD and the system/subsystem requirements should be maintained current with Project development.
2. The system requirements database should be a stand alone set of requirements with its own sequential numbering system. The numbers do not necessarily have to correspond to the MSFC PRD requirement numbers.
3. It is recommended that the initial STEP-AIRSEDS Project system requirements developed by Alpha Technology, Inc. in the filemaker database format be used by the STEP-AIRSEDS contractor as a guide and example in the development of the lower level system requirements.
4. After the complete set of system requirements have been defined in the database format, flowdown analyses should be performed to verify that all the PRD requirements have been flowed down.
5. The verification description, criteria, and compliance information must be defined in the early implementation phase of the Project. The information must be complete and accurate. It is also recommended that a table top review be performed on this information by the project teams to ensure the accuracy and completeness. The verification descriptions defined in the system requirements database and the established verification program must be compatible.

The following documentation items of latest issue was provided to the STEP-AIRSEDS Project Office:

1. STEP-AIRSEDS Project Requirements Document, dated September 25, 2001. (Hardcopy and CD).
2. STEP-AIRSEDS MSFC PRD/TMTC System Requirements Flowdown Matrix, dated September 25, 2001. (Hardcopy and CD).
3. STEP-AIRSEDS MSFC PRD/TMTC PRD Requirements Flowdown Matrix, dated September 25, 2001. (Hardcopy and CD).
4. STEP-AIRSEDS Project System Requirements Database, dated December 15, 2000. (CD).

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6. AUTHORS
Tom Rowell, Lanny Taliaferro

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Alpha Technology, Inc.
3322 South Memorial Parkway, Suite 630
Huntsville, AL 35801

8. PERFORMING ORGANIZATION REPORT NUMBER
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9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
TD15/Mr. Randy M. Baggett
MSFC, AL 35812

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